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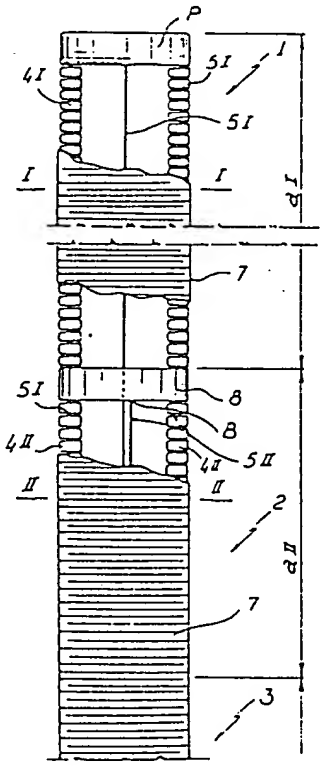
(54) Flexible endoscope.

(57) A flexible endoscope comprising a handle (9), a flexible section (3), a terminal articulated length (1), at least one additional articulated length (2) between the flexible section (3) and the terminal articulated length (1), each articulated length being movable, by two pairs of wires (5I, 5II) connected with servomechanisms, so as to cause the bending of one only or of more articulated lengths simultaneously.

Fig 1



EP 0 301 288 A1

Flexible endoscope.

This present invention refers to a flexible endoscope.

In particular, it is here intenced as flexible endoscope an instrument adapted to carry out an optical survey in a cavity of a human body and possible other operations as a biopsy and a cauterizing, although in general it may be also intended an instrument adapted to carry out observation, checkover, operation into parts of machines, plants and the like.

The prior art comprises flexible endoscopes which transfer the image as taken by an objective on the tip, through a beam of optic fibers, up to an eye-piece on the outer end or supply the image as taken by a micro-television camera on the tip and transferred to a monitor. Said endoscopes are articulable by means of a terminal articulated length which, inside and close to the endoscope tip, holds first ends of four wires being part of two pairs of tension wires placed in two right angle planes, each pair of wires having the second ends connected with a motor means placed into the handle of the instrument and manually operable through a knob which is placed on the endoscope handle and rotatable in either directions. For ease of operation, the two knobs are coaxial. The operation is well known and is summarized as follows: the bending of the terminal articulated length in one plane is caused by one knob (e.g. in a vertical plane: bending up and down); the bending of the terminal articulated length in the plane perpendicular to the above plane is caused by the other knob (e.g. in a horizontal plane: bending right and left).

The operation with the known endoscopes, particularly when used in a gastric or intestinal cavity, is difficult because of the proximity of the cavity wall and said endoscopes involve limitations and difficulties in properly positioning the endoscope tip with respect to the operation area.

A scope of this present invention is to obviate said difficulties and limitations. The invention, as characterized in the claims, provides an endoscope having an articulated portion with high degree of freedom as well as control means for the movements of said portion.

The advantage of this present invention essantially resides in that the endoscope may be operated very easily, in other words, that a physician who is operating in a rather wide cavity, as a human stomach, easily succeeds in placing the endoscope tip conveniently before the point to be observed or operated, whatever the position of said point may be and, furthermore, he succeeds to withdraw the endoscope easily for himself and not detrimentally for the patient.

The invention is set forth herebelow with reference to the drawings which illustrate specific embodiments and wherein:

FIG. 1 is a part view of a first endoscope, partly sectioned;

FIGURES 2 and 3 are, respectively, sectional views from I-I and II-II of FIG. 1;

FIG. 4 is a view from bottom of ring 8 of FIG. 1;

FIG. 5 is a part view showing some positions imparted to the articulated portion of the endoscope;

FIG. 6 is a part view of a second endoscope, partly sectioned;

FIGURES 7, 8, 9 are, respectively, sectional views from I-I, II-II, III-III of FIG. 6;

FIG. 10 is a view of control means of the endoscope of FIG. 6;

FIG. 11 is a view of a third endoscope, partly sectioned;

FIG. 12 is a sectional view from I-I of FIG. 11;

FIG. 13 is a sectional view from II-II of FIG. 11;

FIG. 14 is a view of the handle of an endoscope;

FIG. 15 is the view of the control means of an assembly of motor means in an endoscope;

FIG. 16 is a sectional view from I-I of FIG. 14 and

FIG. 17 is a diagrammatic general view of a fourth endoscope.

Fig. 1 shows that the invented endoscope has two articulated lengths 1, 2. The end of the articulated length 1 bears the tip P which incorporates a micro-television camera together with other auxiliary means that are not shown. The portions of the endoscope parts shown in FIG. 1 are made in a known way: the tip P, the plurality of rings 4I as detailed in FIG. 2, one over the other and held and controlled by four steel wires 5I having their upper ends fixed to the periphery of the tip P passing through corresponding holes 6, an outer flexible sheath 7 made of neoprene, shown only in a part of the figure. The articulated length 1 is $\underline{a}l$ = 8 cm, which portion extends from the end of tip P to the upper end of ring 8 that is the first ring of the articulated length 2. The ring 8 has four holes 6, corresponding to the overhanging rings 4, for fixing the wires 5I, and has the upper ends of other four steel wires 5II fixed to the points B of the lower surface, each wire 5II being positioned to be adjacent to a wire 5I, as visible in Figures 3 and 4. FIG. 3 shows two alternative ways to arrange the plurality of rings 4II: on the left side of line I-I a passage

6, 6' is provided for each wire 5I, 5II; on the right side a passage 6" is provided common to two corresponding wires 5I, 5II. The articulated length 2 is all = 16 cm and is connected in the lower part with a flexible section 3 which is in turn connected with the endoscope handle. The extensions of the articulated lengths al and all will be in accordance with the scope of the endoscope.

Each pair of two diametrically opposed wires 5I belongs to a pair of tension wires arriving at control means located at the opposite endoscope end not shown in FIG. 1; said control means will be described later. Neverthless, it will be realized that, as from known instruments, if in a pair of wires 5I a wire is slackened and the other one is pulled, e.g. the lateral wires in the figure, the articulated length 1 will bend to right or left in the drawing plane; alternatively, if the same operation is carried out with the wires 5I visible in the centre of the figure, then the articulated length 1 will bend in a plane perpendicular to the one of the figure; if two wires are slackened and the other two wires are pulled simultaneously in the two pairs of wires 5I, then the articulated length 1 will bend in a plane within the above mentioned planes. So it will be realized that, if a wire is slackened and the other wire is pulled in one pair of wires 5II, alternatively in the other pair of wires 5II or, simultaneously, in both pairs of wires 5II, then the articulated length 2 will bend as described with reference to the articulated length 1. And then it will be also realized that the combined control of the four pairs of wires 5I, 5II will cause the bending of the articulated length 1 with respect to the articulated length 2 as well as the bending of the latter with respect to the upper end of the flexible part of the endoscope.

In the light of the above, FIG. 5 does not require particular explainations. Attention is only directed to the fact that, among the several combinations of movements which may be imparted to the two articulated lengths 1, 2, there are also those combinations that cause translations of the longitudinal axis of the tip P on lines R parallel with the line III-III of the endoscope in straight position, those which impart to said longitudinal axis positions parallel with a selected line IV and those which maintain for the articulated length 1 the same bend with respect to the articulated length 2, whatever the position of the latter may be.

FIG. 6 diagrammatically shows that part of an articulated two-lengths endoscope which is comprised between the tip P and the juncture of the flexible section 3A with the handle 9; only some of the rings 4I, 4II, respectively in the terminal articulated length 1A and in the additional articulated lenght 2A, are shown in the figure in order not to involve the evidence thereof. The structure of the flexible section and two articulated lengths is covered by an outer flexible envelope 7 made of neoprene. The structure of the flexible section is a cylinder made by a steel wire spiral 21 comprised between the ring 8'A on the upper end of the flexible section and the ring 8"A at the lower end of said section. Also with the help of Figures 7, 8, 9 it is visible that the upper ends of the two first pairs of wires 5I are fastened at A on the lower surface of tip P. Each wire 5I extends into the terminal articulated length 1A through holes 6A in the rings 4I, crosses through the ring 8A and enter a tubular element 20, usually made as a steel wire spiral, extended beetween the lower wall of said ring 8A and the upper wall of a ring 8"A at the lower end of the flexible section 3A.

The upper ends of the two second pairs of wires 5II are fastened at B on the lower surface of said ring 8A, extend into the additional articulated length 2A through holes 6B, cross through said ring 8'A at the upper end of the flexible section 3A and enter a tubular element 22, made by a steel wire spiral, extended between the lower wall of said ring 8'A and the upper wall of said ring 8"A. The extension of the articulated lengths and flexible section is al = 8 cm; all = 16 cm; alII = 150 cm, respectively.

FIG. 10 shows that the lower ends of the wires 5I and 5II arrive inside the handle 9 of the endoscope. The ends of each pair of wires are fastened at the ends of a chain 10 meshing a gear wheel 11 moved by a reduction gear 12 in turn moved by a d.c. electrical motor 13. The assembly AI of said motor means controls the two pairs of wires 5I and the assembly AII of said motor means controls the two pairs of wires 5II. The assembly AII in the figure shows only one pair of wires 5II, only one length of chain 10,only one gear wheel 11 and only one motor-reduction gear 12/13, the remaining ones being covered by the above specified parts.

FIG. 11 diagrammatically shows an endoscope still having two articulated lengths, from tip P to handle 9, whilst FIG. 12 is a sectional view from I-I of FIG. 11. In order not to involve the figures too much, only a single ring 4I in the terminal articulated length 1B and a single ring 4II in the additional articulated length 2B are shown. Due to the same reason, the flexible cover completely wrapping the flexible section and the two articulated lengths is omitted. In the endoscope as illustrated herein, each wire of the two pairs of wires 5II by means of which the movements of the additional articulated length 2B are controlled is a flexible tube made of plastic material or other suitable material which extends from the lower surface of the ring 8 upto the entry into the handle 9 and is kept into a tubular element 23 made of plastic material or other suitable material extended be-

tween the lower wall of said ring 8' at the top of the flexible length 3B and the upper wall of a ring 8'A at the bottom of said flexible section. FIG. 13 makes clear how, along the flexible section 3B, each wire 5I is within a tubular wire 5II which, in turn, is within a tubular element 23.The scope of the latter is to limit the side movement of wire 5II into the flexible section. The head of each flexible tube has a flange 30 which is rivetted on the lower surface of ring 8.

The bottom foot of each flexible tube comprises a funnel-shaped element 31 the lower end of which is fastened, directly or by means of a steel wire 5II, to a chain 10 meshing a gear wheel 11 moved by a d.c. electric motor 12, which can ratate in the two directions, through a speed reduction gear 13 in the assembly of motor means AII. Each funnel-shaped element 31 has an aperture 32 in its own conical wall. Each wire of the two pairs of wires 5I, which control the movements of the terminal articulated length 1B, has the upper end fastened at A on the lower wall of tip P, passes through a hole in the ring 8, enters into the top of a flexible tube 5II and comes out therefrom through the aperture 32 of a funnel-shaped element 31. Each wire 5I has the bottom end directly fastened to a chain 10 in the assembly of motor means AI.

The illustrated assemblies of motor means comprise a gear wheel and a chain meshing said gear wheel. It will be realized that theese parts may be replaced, respectively, by a pinion and by two racks each of which is connected with the lower end of a wire.

FIG. 14 shows a pair of control means for the electric motors 13, which pair is located on the face 19 of the handle 9. A control means CI comprises a round cover 14 made of neoprene which covers four push buttons shown by the dashed areas 15I, 16I, 17I, 18I for controlling the motors in the assembly AI by the pressure of a finger. The operation of the control means CII with respect to the assembly AII is identical. If , alternatively, the button under the area 15I or 16I of the control means CI is pushed, then it is made to run in a direction or in the opposite direction that motor 13 which controls the pair of wires 5I that causes the movement of the articulated length 1 in the plane perpendicular to the handle face 19; if, alternatively, the button 17I or 18I is pushed, then it is made to run in a direction or in the opposite direction the other motor 13 in the assembly AI which controls the pair of wires 5I that causes the movement of the articulated length 1 in a plane parallel with the handle face 19. It will be realized that, if simultaneously a button corresponding to a wire pair and a button corresponding to the other wire pair of one of the control means is pushed, then a movement as combination of two movements in perpendicular planes is caused. If the buttons of the control means CII are pushed, then the two wire pairs 5II are moved, identically as described in connection with the control means CI.

FIGURES 15 and 16 show a control means similar with the means CI illustrated in FIG. 13, but such that it allows to easily impart to the articulated length corresponding to said control means a movement that is the combination of two movements in perpendicular planes just pushing by a finger one single point of the control means. In fact, as illustrated with reference to FIG. 14, still a round cover 14, made of neoprene, covers four buttons 15I, 16I, 17I, 18I, for controlling the two motors in an assembly of control means, and a substantially square small plate 36 held in the cover center by a pin 17. An elical spring 39, round the pin under the small plate 36, biases the latter against the head of the same pin. So, it will be realized that, for instance, if pressure is applied exactly to that vertex of the small plate 36 which corresponds to the button 15I or 18I, then a single movement is imparted to the terminal articulated length; if pressure is applied to a point 15/18, at half span between 15I and 18I, then a movement as resultant of two perpendicular mevements is imparted to the terminal articulated length.

FIG. 17 illustrates a flexible endoscope wherein the assemblies of motor means (not shown) are received in a box 34 which is kept apart from the endoscope. The latter comprises the articulated lengths 1,2, flexible section 3 and handle 9 incorporating control means CI, CII. The box 34 is connected with the endoscope by means of a neoprene tube 35 wherein the pairs of wires 5I, 5II are passed to move the two articulated lengths and a cable is passed to feed with electric power the four motors of the type " direct current torque motor "which has a low number of revolutions and does not require a speed reduction gear between the motorand the transmission means. The neoprene tube 33 is required to lead into the endoscope electrical cables, a beam of optic fibers for the lighting means on the endoscope tip, a duct for air blowing, a duct for air sucking, a duct for water and other possible cables and ducts for auxiliary operations.

Modifications in some details of the described endoscope may be brought without departing from the area of the invention. For instance, the articulated lengths 1, 2 comprise, instead of the plurality of divided rings 4I, 4II, a different structure allowing for an equivalent articulation under the action of the pairs of wires 5I, 5II, consequently a continuous and flexible structure or a discontinuous one wherein the single elements or rings are connected each other in an articulated manner, so as to form vertebrate lengths which are on the whole articula-

ble in any direction. Moreover, it is obvious that the movement may be imparted to the articulated lengths 1, 2 by conventional motor means manually moved, instead of by electrical motors.

Claims

1. A flexible endoscope comprising an handle (9) for an operator, control means on said handle to operate the endoscope, a flexible section (3), a first terminal articulated length (1) composed by a plurality of articulate ring elements (4I) and controlled by said control means by motor means and two first pairs of wires (5I) passing through holes in said plurality of articulate ring elements (4I), means on the tip (P) of the terminal length (1) for taking images in the cavity where the operation is in course and transmitting them outside, means for lighting said cavity, for washing said cavity and said means for taking the images, means for carrying out the conventional additional operations,characterized in that it also comprises, between said flexible section (3) and said terminal articulated length (1), at least an additional articulated length (2) controlled by control means on said handle (9) through motor means and two second pairs of wires (5II), each pair of said wires (5II) having the upper end fastened to a ring (8) at the upper end of the additional articulated length (2) and the lower end fastened to a motor means able to pull a wire and slack the other wire, each motor means for each articulated length (1, 2) being an assembly (AI, AII) comprising a pair of electric motors (13) provided with the two revolution directions, each associated with means (10, 11) adapted to impart a linear movement, in one direction or in the other one, to the lower ends of a pair of wires (5I, 5II), each assembly of motor means (AI, AII) being controlled by an assembly of means (15I, 16I, 17I, 18I) located on an outer face of the handle (9).

2. A flexible endoscope according to claim 1 characterized in that part of each wire of the two first pairs of wires (5I) is into a tubular flexible element (20) extended between the upper end of the articulated length (2) adjacent to the terminal articulated length (1) and the lower end of the flexible section (3); part of each wire of the second pairs of wires (5II) is into a tubular element (22) extended from the upper end to the lower end of said flexible section (3).

3. A flexible endoscope according to claim 1 characterized in that each wire of the two second pairs of wires (5II) is a tubular flexible and unextensible element (5II) having the upper end fastened to the lower wall of said ring (8) at the upper end of the additional articulated length (2) and the lower end connected with an end of a corresponding transmission element (10) in an assembly of motor means (AII), each of said wires (5II) being received into a tubular element (23) extended between a ring (8') at the top of the flexible section (38) and a ring (8"A) at the bottom of said flexible section, and each wire of the two first pairs of wires (5I) passes into an aperture of said ring (8) and, therefrom, into said tubular element (5II) to come out at the lower part thereof and fasten to an end of a corresponding transmission element (10) in an assembly of motor means (AI).

4. A flexible endoscope according to any one of claims 1, 2, 3 characterized in that the motor means for the articulated lengths (1, 2) are located within the endoscope handle (9).

5. A flexible endoscope according to any one of claims 1, 2, 3 characterized in that the motor means for the articulated lengths (1, 2) are received in a box (34) apart from the endoscope.

6. A flexible endoscope according to any one of claims 1, 2, 3, characterized in that the assembly of means on the outer face (19) of the endoscope handle (9) is an assembly of push buttons, two of said buttons (15I, 16I) being adapted to impart, alternatively, the revolution movement in a direction or in the opposite direction to a first electric motor (13), two of said buttons (17I, 18I) being adapted to impart, alternatively, the revolution movement in one direction or in the opposite direction to a second electric motor (13).

7. A flexible endoscope according to claim 1 characterized in that the ring (8) at the upper end of each additional articulated length (2) has a passage (6) for each wire (5I, 5II) associated with the overhanging articulated lengths (1, 2) and holds the upper ends of each wire (5II) associated with the corresponding additional articulated length (2).

8. A flexible endoscope according to claims 1 and 7 characterized in that each additional articulated length (2) comprises a plurality of articulate ring elements (4II) which carry passages (6) for the wires (5I) associated with the terminal articulated length (1) and separate passages (6') for the wires (5II) associated with the additional articulated lentghs (2).

9. A flexible endoscope according to claim 8 characterized in that each ring element (4II) comprised in the additional articulated lengths (2) carries passages (6") for a wire (5I) associated with the terminal length (1) and for one wire or wires (5II) associated with additional articulated lengths (2).

10. A flexible endoscope according to the preceding claims characterized in that the wires belonging to the two pairs of wires of the terminal articulated length (1) are adjacent to the wires belonging to the two pairs of wires of the additional

articulated lengths (2) so as to provide pairs of wires (5I, 5II) in a plane perpendicular to other pairs of wires (5I, 5II).

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 11 0845

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	DE-A-3 504 824 (SCHÖLLY FIBEROPTIC) * Abstract; page 4, lines 1-17; page 9, line 20 - page 10, line 10; page 11, line 1 - page 12, line 9; page 12, line 33 - page 13, line 16; figures 1-10 *	1,4,7-9	A 61 B 1/00 G 02 B 23/24
A	---	10	
Y	WO-A-8 402 196 (J.E. HADUCH) * Abstract; page 9, lines 7-13; page 10, lines 8-22; page 11, lines 7-21; page 12, line 1 - page 13, line 3; page 13, line 12 - page 14, line 21; figures 1-9 *	1,4,7-9	
A	---	2,3	
A	EP-A-0 078 017 (OLYMPUS OPTICAL) * Abstract; page 5, line 9 - page 6, line 14; figure 1 *	1,4,6	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

A 61 B
A 61 M
G 02 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18-10-1988	FERRIGNO, A.

CATEGORY OF CITED DOCUMENTS

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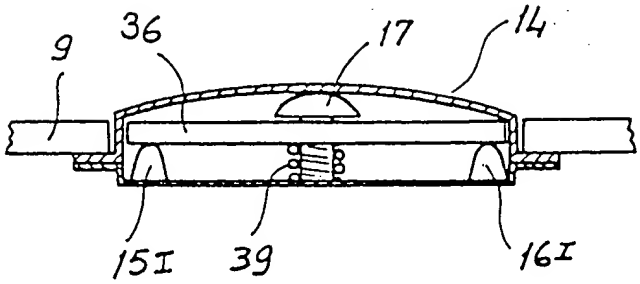
Fig. 16



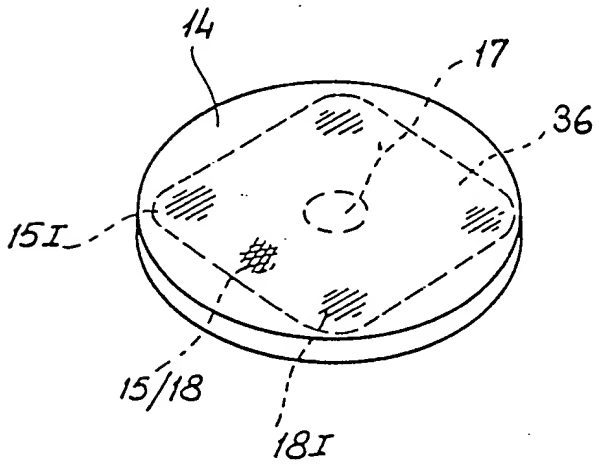


Fig.15

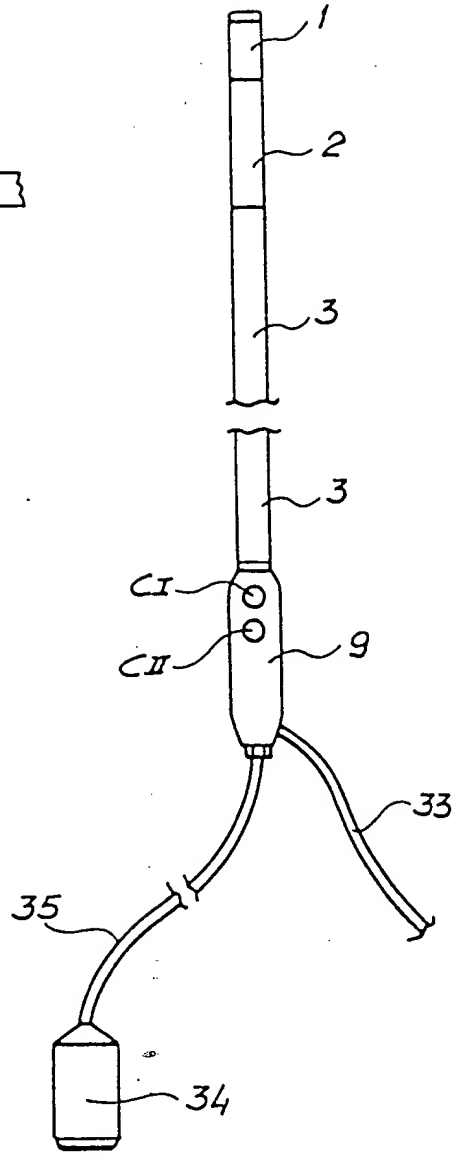


Fig.17

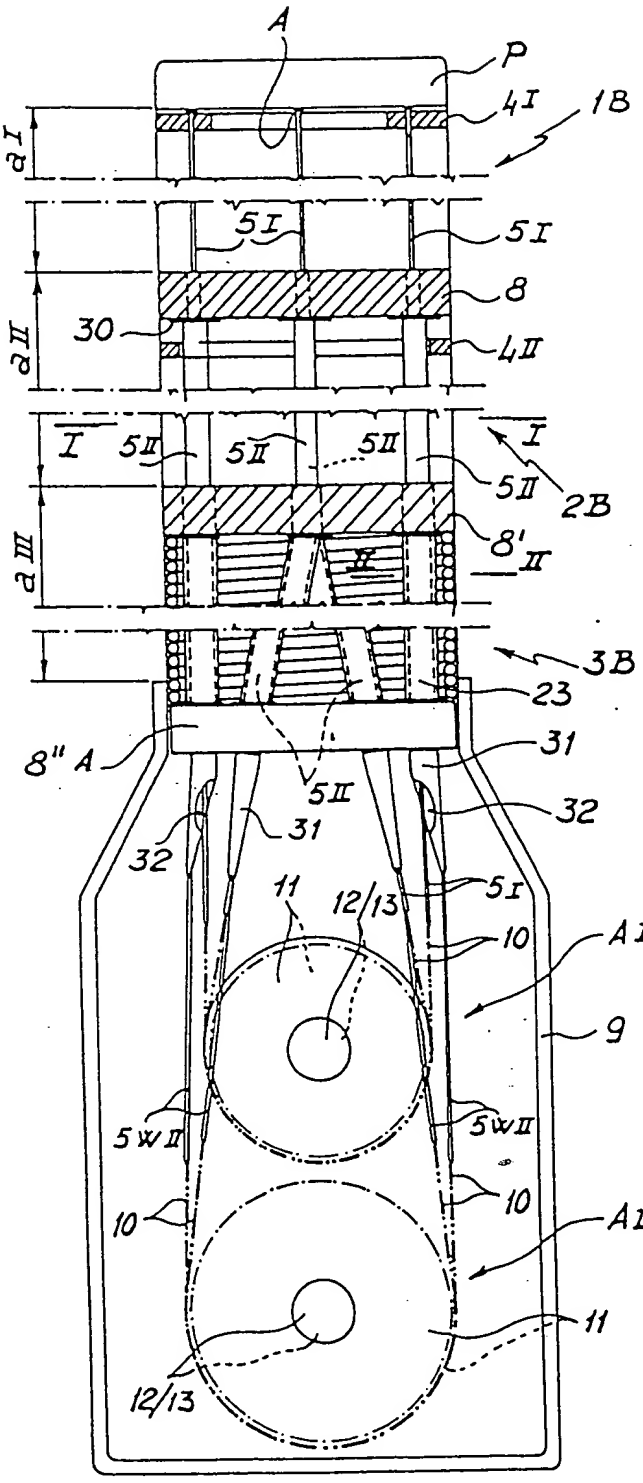


Fig. 11

Fig. 12

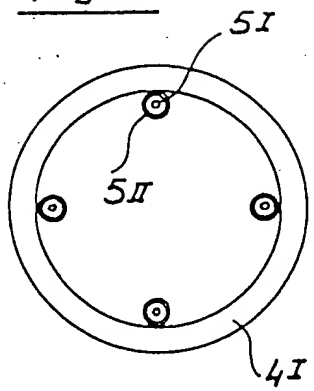


Fig. 13

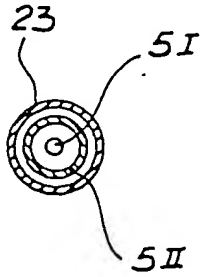
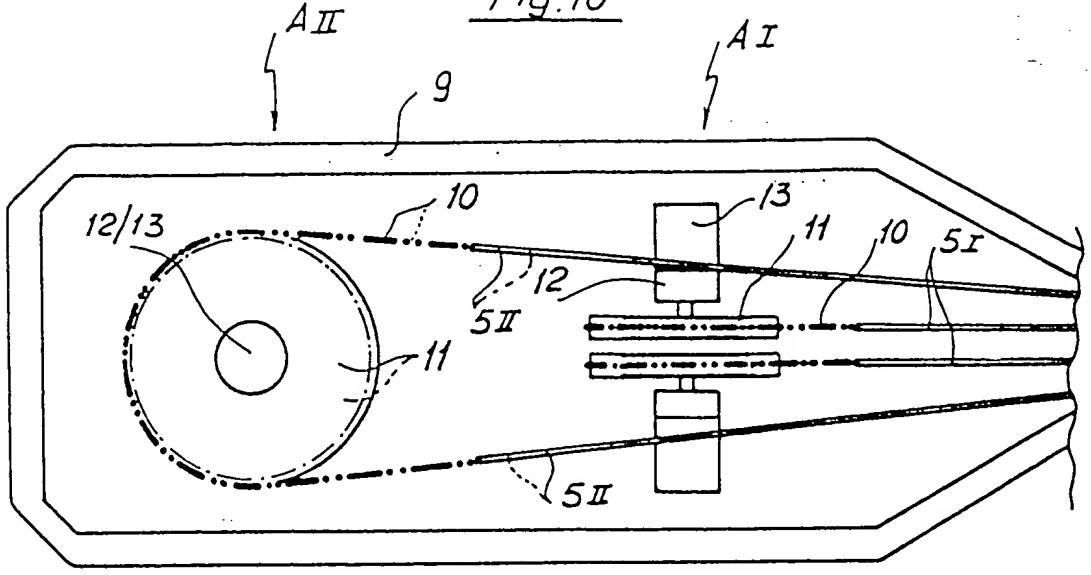


Fig.10


AII
AI
9
10
13
12/13
11
10
5I
12
5II
11
5II

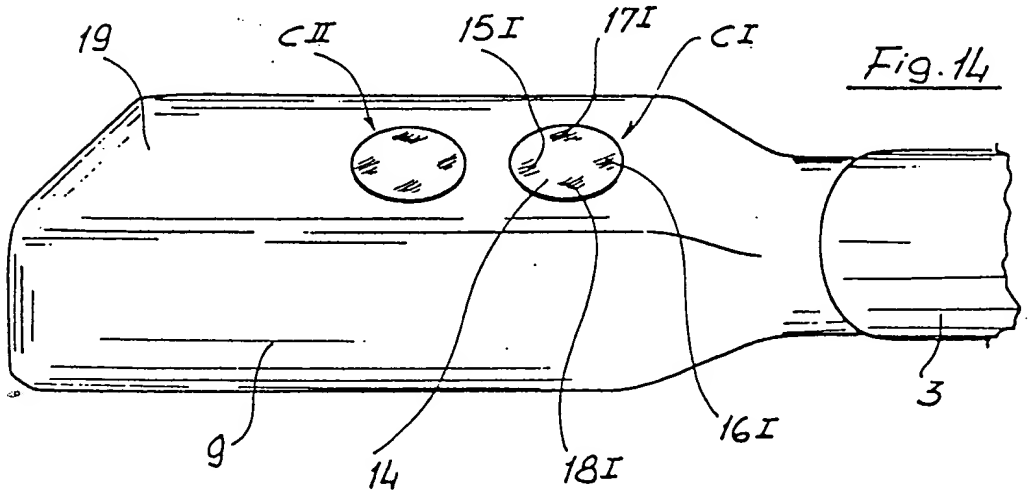

19
CII
15I
17I
CI
9
14
18I
16I
3

Fig.14

Fig.6

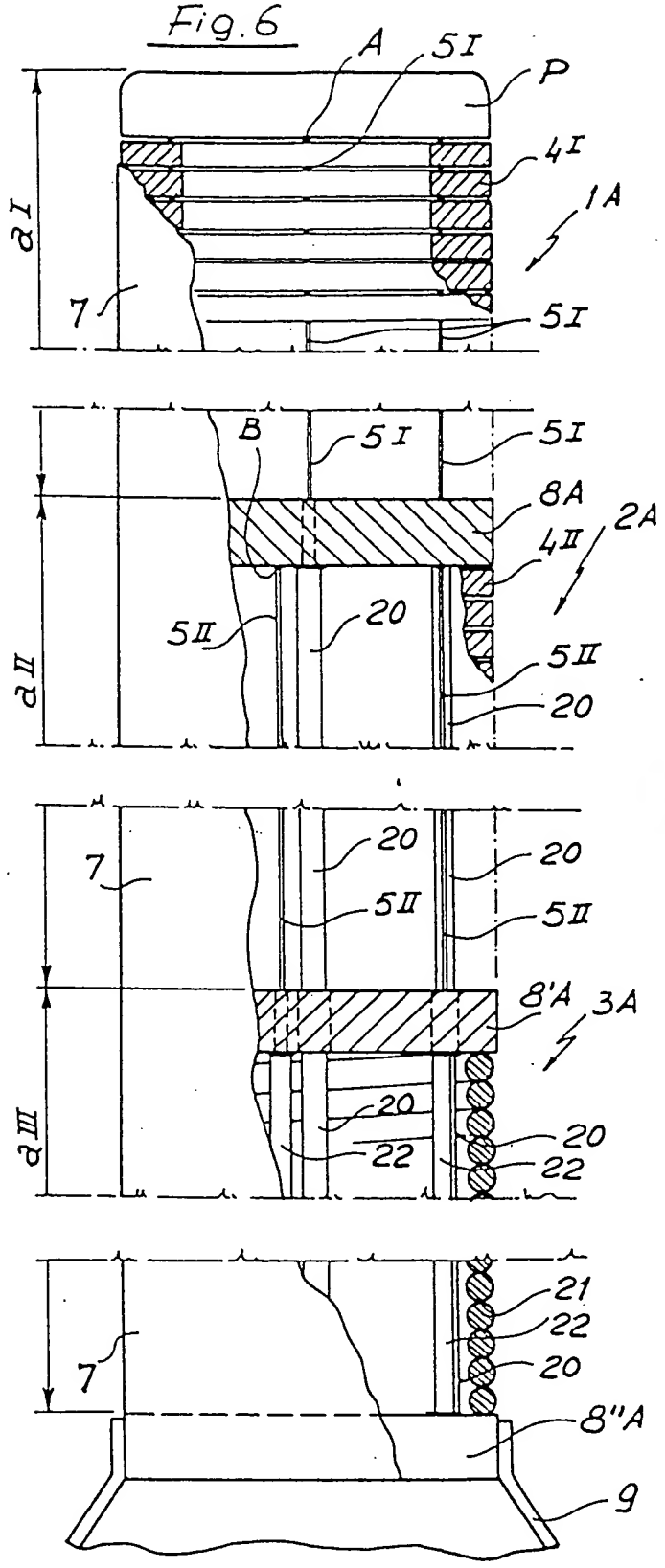


Fig.7

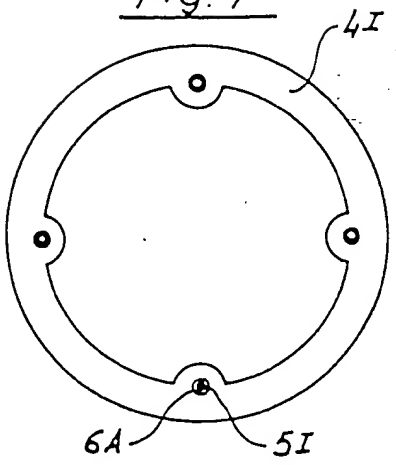


Fig.8

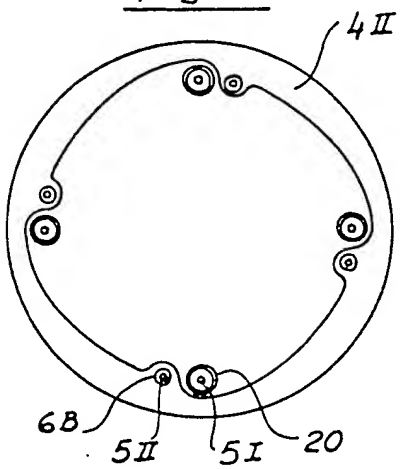
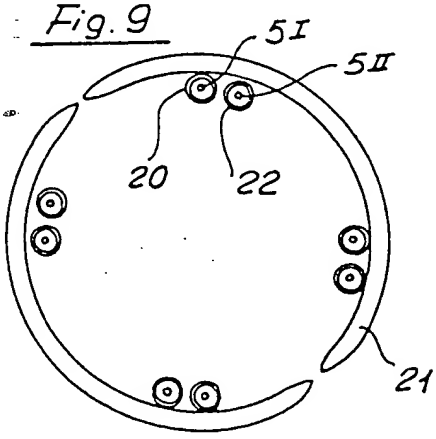


Fig.9



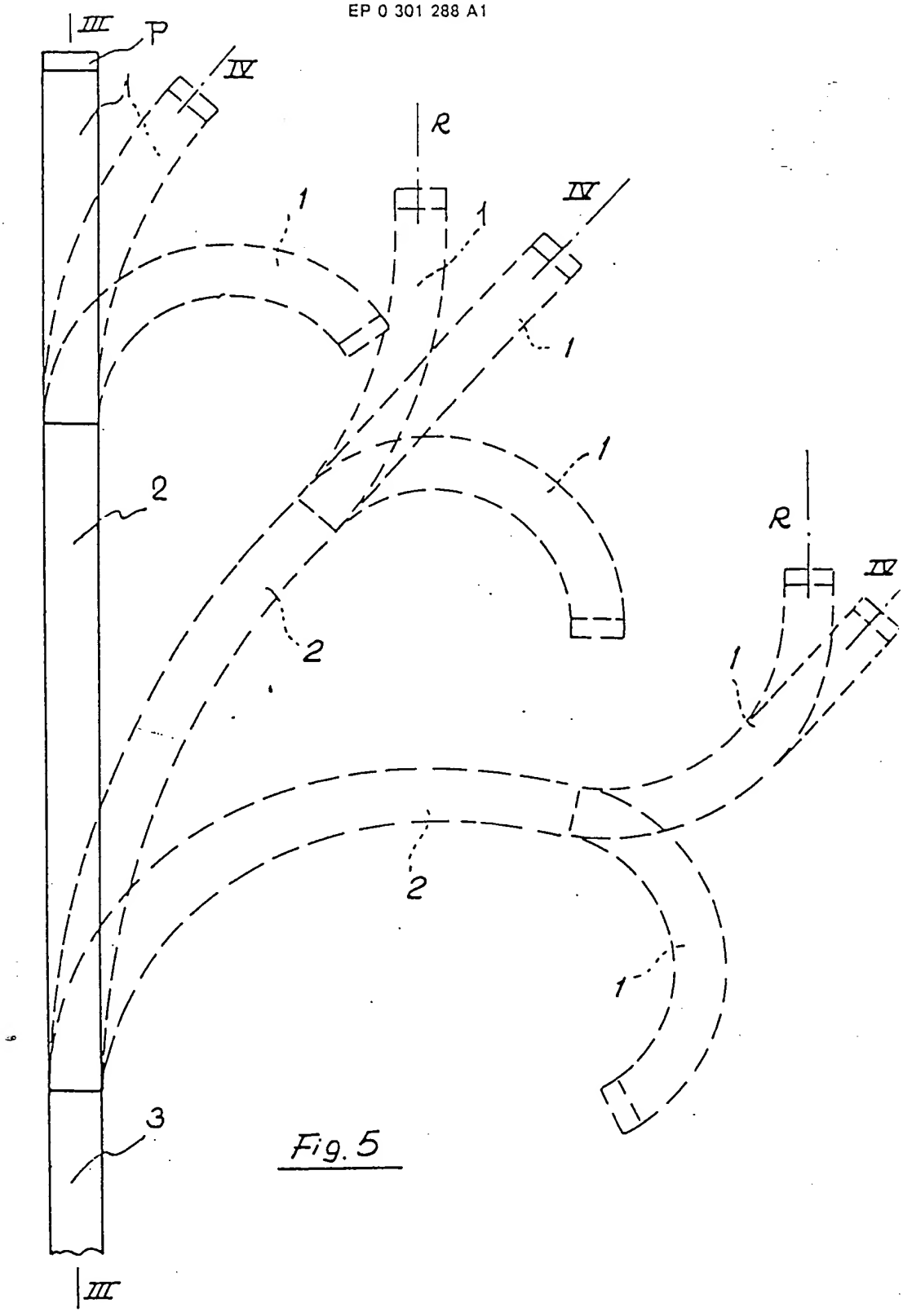


Fig. 5

Fig. 1

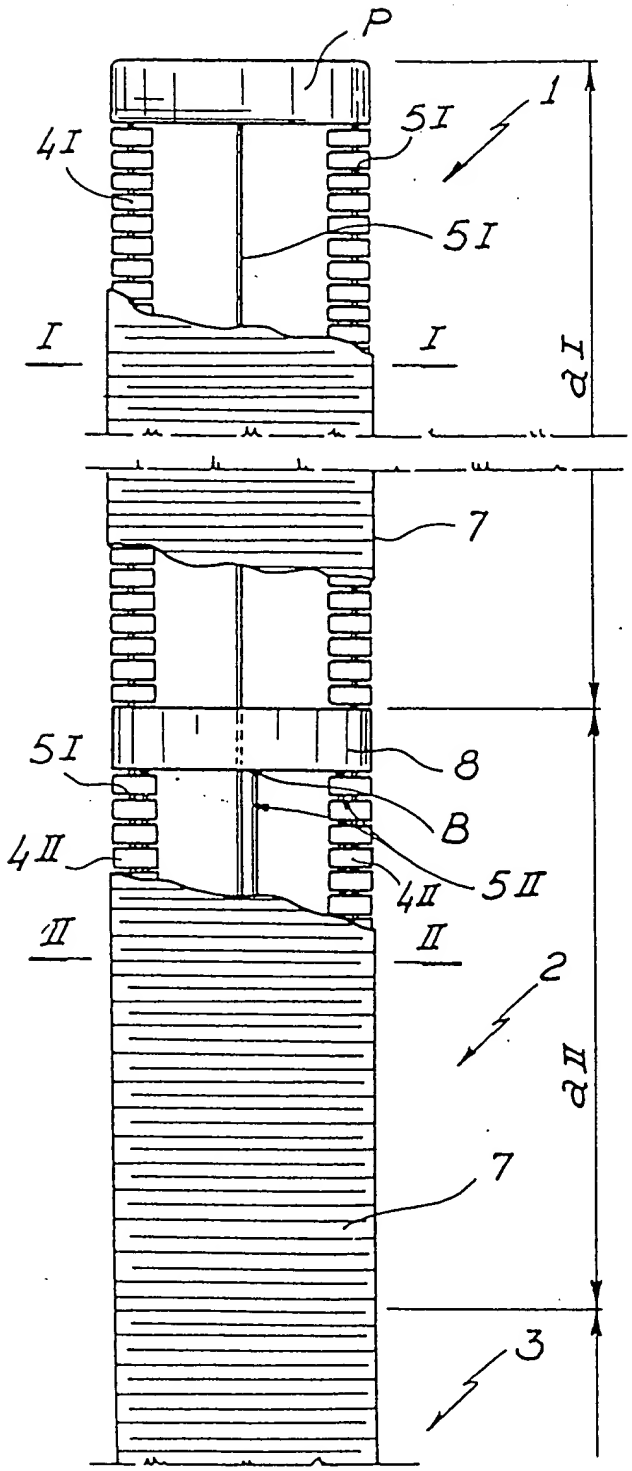


Fig. 2

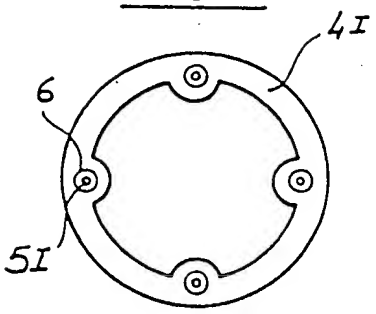
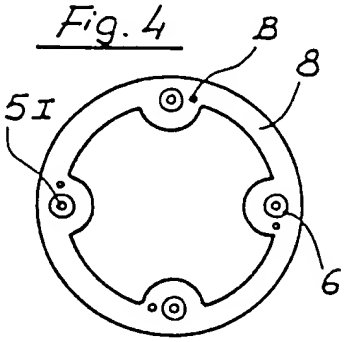


Fig. 4



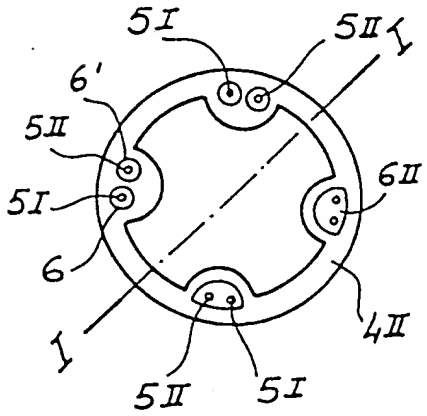


Fig. 3